Amendments to the claims are indicated in the attached "Marked Up Version of Amendments" (pages i - iv).

Please add new Claim 58.

a9

58. (New) The system as claimed in Claim 1, wherein said filter and amplifier are combined in a single stage.

REMARKS

Claims 1-57 are pending in the application. Of these claims, Claims 14-19, 33, 34, and 51-55 were withdrawn from consideration without traverse in a Reply to Restriction Requirement filed December 20, 2002 (referred to in the Office Action at hand as Paper No. 7). Claims 3, 13, 32, and 50 were rejected under 35 U.S.C. 112, second paragraph. Claims 1-6, 13, 20-28, 32, 35-43, 50, and 57 were rejected under 35 U.S.C. 102(b) as being anticipated by Harms et al. (U.S. Patent No. 5,220,836). Claims 1-4, 6, 13, 20-26, 28, 32, 35-41, 43, 50, 56, and 57 were rejected under 35 U.S.C. 102(a) as being anticipated by Pflueg (U.S. Patent No. 6,205,872). Claims 1-4, 6-11, 13, 20-26, 28-32, 35-41, 43-48, 50, 56, and 57 under 35 U.S.C. 102(b) as being anticipated by Flechsig et al. (U.S. Patent No. 6,092,412). Claims 1-9, 12-13, 20-21, 23, 32, 37-38, 50, and 57 are amended. Claim 58 has been added. No new matter is introduced.

Claims 3, 13, 32, and 50 have been amended and should now be in condition for allowance under 35 U.S.C. 112, second paragraph. With regard to Claim 3, the antecedent basis has been corrected. With regard to Claims 13, 32, and 50, the now recited "input impedance of greater than 10 Mohms" is schematically shown in Fig. 2.

Before discussing the specific rejections of the Office Action at hand, the Applicant believes that a brief discussion of the application and cited references may be useful.

The present invention is directed to a transducer that may be mechanically connected to an object to measure its motion or force. When this motion is vibrational, usually only certain frequency ranges are of interest. In such cases, the transducer must provide some means of filtering out the unwanted frequencies. To achieve this filtering, the transducer includes (a) a sensor element (e.g., piezoelectric element) providing an output signal with a broad frequency

range and (b) an amplifying and filtering circuit that is electrically connected to the sensor element to process the output and to eliminate unwanted frequencies outside a given frequency band of interest. The sensor element typically has a linear operating region and a resonance frequency outside the linear operating region.

Traditional transducers are designed for sensing either low-frequency vibrations or high-frequency vibrations. To obtain signals representing both the low-frequency vibrations and high-frequency vibrations, two transducers are generally used.

The present invention teaches a transducer that can operate with a single sensor and an electronic circuit that includes two channels, each of which includes a filtering circuit providing separate outputs. By combining at least two filtering functions into a single circuit that can convert a single sensor output into corresponding electrical signals, the transducer is reduced in size, weight, and cost, and provides improved performance for measurement systems where measurement of multiple frequency signals are needed.

To achieve the improved performance, at least one of the two channels is essentially directly electrically coupled to the sensor. As shown in Fig. 1, a sensor 1 is (i) directly connected to a low-pass filter channel circuit 2 and (ii) to a high-pass filter channel circuit 4 through a buffer 10. A corresponding detailed schematic is shown in Fig. 2, where the output of the sensor at node T1 is transmitted to the input of the low-pass filter (and charge amplifier combined in a single stage) at the base of J6 through resistors R3 and R4. Additionally, the low-pass filter channel circuit 2 and buffer 10 each has high input impedance (greater 10 Mohm) and therefore does not degrade the performance of the sensor 1.

Thus, the channel including the low-pass filter is essentially directly connected to the sensor as stated in the specification as originally filed at page 5, line 25. The other channel, in this embodiment, is electrically connected to the sensor via the buffer 10 (U1 in Fig. 2), which may be employed to decouple the second channel from the first channel. As listed on page 10, line 25 of the specification as originally filed, the residual noise for the low-pass filter channel output (2 Hz to 20 kHz) is 25 μVrms, and the residual noise for the high-pass filter channel (2 Hz to 100 kHz) is 22 μVrms. The unique design allows the circuit to achieve such low levels of noise over such a wide dynamic range.

Accordingly, amended Claim 1 recites, "an electronic circuit . . . including at least two channels each including a filter . . ., at least one of said at least two channels essentially directly electrically coupled to the sensor."

Harms et al. (U.S. Patent No. 5,220,836) teaches a method and arrangement for a piezoelectric measurement. The Harms et al. circuit, in the embodiment of Fig. 1 and discussed in Col. 11, lines 1-14, includes a charge amplifier 3 and resonance detector 4. However, the charge amplifier and resonance detector are electrically connected to a sensor via an inductor and capacitor, respectively, which decouple the signals coming from the sensor on a common signal line 2 and are not merely used for impedance matching of the sensor. Moreover, the use of the inductor creates a resonance in combination with both the capacitor and the sensor that degrades performance of the system. Thus, neither the charge amplifier nor the resonance detector is directly electrically coupled to the sensor.

To improve upon the simple L-C circuit used to decouple the channels from the sensor, Harms et al. provides a second embodiment, shown in Fig. 4. In this embodiment, the sensor 1 is connected to a negative input of an operational amplifier 5. The operational amplifier 5 decouples the sensor 1 from the high-pass filter 9 and low-pass filter. In addition, the combination of signal generator 7 and operational amplifier 5 contribute additional amplifier noise and decrease the dynamic range of the system. Thus, in neither embodiment is either channel (i.e., charge amplifier/resonance detector or high-pass filter/low-pass filter) "essentially directly electrically coupled to the sensor."

Referring now to Pflueg (U.S. Patent No. 6,205,872), Pflueg teaches a broadband vibration sensor in which transducers 44 and 60 (Fig. 3) are connected to independent transducer circuits 42 (Fig. 5), shown interconnected in Fig. 7A. The transducer outputs are amplified through at least two amplifiers 78, 86 or 80, 88 before being split into separate filter channels (Fig. 7B). Accordingly, neither of the channels that process the associated signals from the sensors is "essentially directly electrically coupled to the sensor."

Referring now to Flechsig et al. (U.S. Patent No. 6,092,412), Flechsig et al. teach a glide height test signal processor and method using increased high frequency components. This type of device may be used in a conventional magnetic storage device, where an air bearing slider supports a magnetic transducer in close proximity to a relatively moving recording surface. The

magnetic transducer is shown in Fig. 7 as PZT glide heads 710 that provide a signal to a preamplifier 720. The output from the preamplifier is split into two channels 737 and 747 for application of gain and filtering. Thus, although Flechsig et al. teach a system that includes a vibration sensor and two channels, neither channel is "essentially directly electrically coupled to the sensor."

35 U.S.C. § 102

Although Harms et al., Pflueg, and Flechsig et al. disclose systems for converting sensed force into electrical signals including a sensor and an electronic circuit including two channels, none of these references teaches "at least one of said at least two channels essentially directly electrically coupled to the sensor." As discussed above, each of these references includes at least one amplifier or passive element (i.e., capacitor or inductor) to isolate the channels from the sensor.

Therefore, the Applicant respectfully submits that the rejections under 35 U.S.C. § 102 should be withdrawn with regard to these three cited references.

Because Claims 2-13 and 20-22 depend from Claim 1, these claims should be allowed for at least the same reasons.

Independent Claim 23 has been amended to include similar claim limitations as Claim 1 ("the channelizing including essentially directly channelizing the electrical signal into at least one of the channels"). Therefore, Claim 23 should be allowable under 35 U.S.C. § 102 for similar reasons as discussed above.

Because Claims 24-32 and 35-36 depend from Claim 23, these claims should be allowed for at least the same reasons.

Independent Claim 37 has been amended to include similar claim limitations as Claim 1 ("means for channelizing including essentially directly channelizing said electrical signal into at least one of said two channels"). Therefore, this claim should be allowed under 35 U.S.C. § 102 for similar reasons as discussed above.

Independent Claim 38 is a circuit claim that has been amended to include similar claim limitations as Claim 1 ("at least one of said at least two filter modules being essentially directly

coupled to the circuit input"). Therefore, this claim should be allowed under 35 U.S.C. § 102 for similar reasons as discussed above.

Claims 39-50 and 56-57 depend from Claim 38 and should be allowed for at least the same reasons.

CONCLUSION

In view of the above amendments and remarks, it is believed that all now pending claims (Claims 1-13, 20-32, 35-50, 56-58) are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned at (978) 341-0036.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

By Mark B Solomon

Mark B. Solomon
Registration No. 44,348
Telephone: (978) 341-0036
Facsimile: (978) 341-0136

Concord, MA 01742-9133
Dated: 4/15/03

OIPE JC46
APR 2 1 2003
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MARKED UP VERSION OF AMENDMENTS

Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

1. (Amended) A system for converting sensed force or mechanical motion into corresponding electrical signals, comprising:

a sensor providing an electrical signal as a function of sensed force or mechanical motion;

an electronic circuit (i) electrically coupled to the sensor to receive the electrical signal as an input and (ii) including at least two [filters] channels each including a filter to filter the received electrical signal and provide respective corresponding electrical signals as outputs, at least one of said at least two channels essentially directly coupled to the sensor.

2. (Amended) The system as claimed in Claim 1, wherein said at least [two filters include] one of said at least two channels includes a low-pass filter and the other of said at least two channels includes a high-pass filter.

3. (Amended) The system as claimed in Claim 2, wherein the low-pass filter passes frequencies in [the] a linear region of the sensor and the high-pass filter passes [the] a resonance frequency of the sensor.

4. (Amended) The system as claimed in Claim 1, wherein said at least two [filters filter and] channels further include an amplifier to amplify the electrical signal.

5. (Amended) The system as claimed in Claim 1, wherein said at least two [filters filter, amplify, and offset] channels further include an amplifier and offset circuit to amplify and offset the electrical signal.

6. (Amended) The system as claimed in Claim 1, wherein inputs to said at least two [filters] channels are electrically isolated from one another.

7. (Amended) The system as claimed in Claim 1, wherein the electronic circuit further includes a buffer to isolate the inputs of said at least two [filters] channels from one another.

8. (Amended) The system as claimed in Claim 7, wherein the buffer is electrically disposed between the sensor and at least one of the [filters] channels.

9. (Amended) The system as claimed in Claim 8, further including at least one high impedance element to provide the output electrical characteristics of the sensor to [filters] channels not coupled directly to the sensor.

12. (Amended) The system as claimed in Claim 7, wherein one of the [filters is] channels includes a low-pass filter and power is supplied to the buffer by the output of the low-pass filter.

13. (Amended) The system as claimed in Claim 1, wherein the [filters] channels have [high] an input impedance greater than 10 Mohm.

20. (Amended) The system as claimed in Claim 1, wherein [the filters include] channels include a passive low-pass filter circuit.

21. (Amended) The system as claimed in Claim 1, wherein [the filters include] at least one of the channels includes a passive high-pass filter circuit.

23. (Amended) A method for converting sensed force or mechanical motion into corresponding electrical signals, comprising:

providing an electrical signal as a function of sensed force or mechanical motion;

[filtering] channelizing the electrical signal into at least a first channel and a second channel filtering the electrical signal into a first frequency band and a second frequency band respectively, the channelizing including essentially directly channelizing the electrical signal into at least one of the channels; and

outputting the electrical signal in the first frequency band and the second frequency band independently.

32. (Amended) The method as claimed in Claim 23, wherein said filtering the electrical signal includes [high-impedance] an impedance greater than 10 Mohm for sensing the electrical signal.

37. (Amended) A system for converting sensed force or mechanical motion into corresponding electrical signals, comprising:

means for providing an electrical signal as a function of sensed force or mechanical motion; and

means for [converting] channelizing said electrical signal into at least two [filtered signals] channels including means for filtering the electrical signal, said means for channelizing including essentially directly channelizing said electrical signal into at least one of said two channels.

38. (Amended) An electronic circuit for processing an electrical signal corresponding to a sensed force or mechanical motion, comprising:

a circuit input, to receive an electrical signal corresponding to the sensed force or mechanical motion; and

at least two filter modules coupled to the circuit input to filter the electrical signal and provide respective filtered electrical signals on respective circuit outputs, at least one of said at least two filter modules being essentially directly coupled to the circuit input.

50. (Amended) The electronic circuit as claimed in Claim 38, wherein at least one of said at least two filter modules has [high] an input impedance greater than 10 Mohm.

57. (Amended) The electrical circuit as claimed in Claim 38, wherein at least one of said at least two filter modules includes a passive high-pass filter circuit.